AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS, INC.
1791 Tullie Circle, NE Atlanta, GA 30329 404-636-8400

TC/TG/TRG MINUTES COVER SHEET

(Minutes of all meetings are to be distributed to all persons listed below within 60 days following the meeting.)

TC/TG/TRG NO. TC 7.5 DATE: January 2004

TC/TG/TRG TITLE: Smart Building Systems

DATE OF MEETING: January 27, 2004 LOCATION: Anaheim, CA

Members Present	Appt	Members Absent	Appt	Ex-Officio Members and Additional Attendance
John House, Chair (V)	03-05	Osman Ahmed (V)	02-06	Narendra Amarnani
Michael Brandemuehl (V)	03-07			David Bornside
James Braun (V)	03-07			Daniel Choiniere
Natascha Castro, Testing & Evaluation Subc, Web Master (V)	02-04			Piotr A. Domanski
Arthur Dexter, International member (V)	01-05			Bill Healy
Cliff Federspiel (V)	02-06			Gregor Henze
James W. Gartner (V)	03-07			Richard Kelso
Rich Hackner, Program Subc. (V)	01-05			
Carlos Haiad (V)	00-04			Chris Scruton
Phil Haves (V)	01-05			Matthew Tyler
Srinivas Katipamula; Tech. Dev. Subc. Chair (V)	01-05			Hossein Vaezi-Nejad
Agami Reddy (V)	02-06			Jim Wen
Jonathan Wright (V)	03-07			Jensen Zhang
		Corresponding Members		
Corresponding Members		Charles Culp, CM	00-	
Steve Blanc, CM	03-	Thomas Engbring, CM	99-	
Mike Brambley, Vice Chair, Research Subc Chair (CM)	03-05	David Kahn, CM	96-	
Dave Branson, CM	01-	Michael Kintner-Meyer, CM	03-	
Barry Bridges, CM	02-	Mingshang Liu, CM	03-	
Marty Burns, CM	02-	Carol Lomonaco, Program Subc, CM	00-	
Jim Butler, CM	02-	Darrell Massie, CM	03-	
Maria Corsi, CM	03-	John Mitchell , CM	00-	
George Kelly, CM	00-	Ron Nelson, CM	98-	
Robert Old, CM	01-05	Hung Mahn Pham, CM	01-	
Glenn Remington, CM	02-	Les Norford, Handbook Subc., CM	02-	
Todd Rossi, Secretary, CM	03-	Mike Panchak, CM	03-	
John Seem, CM	03-	Kinga Porst, CM	02-	
Pornsak Songkakul, CM	02-	Andrew Price, CM	03-	
		Barry Reardon, CM	99-	
Peng Xu, Comm. & Int. Subc. Chair, CM	02-	Keith Temple, CM	03-	
Chariti Young, CM	02-	James Winston, CM	02-	
		Xiachui Zhou, CM	03-	

(V) = voting member, Membership status as of 9/02

DISTRIBUTION:
ALL MEMBERS AND CORRESPONDING MEMBERS OF TC/TG/TRG,
TAC CHAIR: Mark Hegberg
TAC SECTION HEAD: Patricia Thomas Graef
ALL COMMITTEE LIAISONS AS SHOWN ON TC/TG/TRG ROSTERS:

Program: Elizabeth Parke	Staff Liaison (Resch/Tech Srvc): Michael Vaughn
Research: Wayne Reedy	Staff Liaison (Stds): Claire Ramspeck
TEGA: Kenneth Rhoden	Manager Of Standards: Richard Hermans
ALI: Samuel Cummings Jr.	Special Publications: Marilyn Listvan

ASHRAE TC Activities Sheet

DATE:
TC NO. TC7.5 TC TITLE: Smart Building Systems
CHAIR: John House VICE CHAIR: Mike Brambley

TC Meeting Schedule

Location, past 12 mo.	Date	Location, next 12 mo.	Date
Kansas City	7/1/03	Nashville	6/29/04
Anaheim	1/27/04	Orlando	2/5/05

TC Subcommittees

Subcommittee	Chair
Technology Development	J. House
Communications and Integration	R. Hackner
Testing & Evaluation	Natascha Castro
Research	M. Brambley
Program	R. Hackner

Research Projects

1274-RP Field Performance Assessment of Package Equipment to Quantify the Benefits of Proper Service

1275-RP Evaluation and Assessment of Fault Detection and Diagnostic Methods for Centrifugal Chillers – Phase II

2003-2004 Research Plan

Priority	Project	Contributors	Status
1	Field Performance Assessment of Package Equipment to Quantify the Benefits of Proper Service (1274-TRP)	Todd Rossi Mark Breuker Jim Braun	RTAR rejected 9/00. Revised RTAR to be submitted by 8/01/01 as priority 1 RTAR for 2001. Revised RTAR approved 9/01. WS approved in Atlantic City 10-0-0 (CNV). WS submitted to RAC 5/15/02. Returned by RAC (Honolulu). WS approved in Honolulu subject to minor revisions WS approved by RAC in Spring 2003 (co-funding from DOE and CEC) Proposals received by ASHRAE and reviewed by the PES. TC 7.5 Executive Session to meet for vote on contractor recommendation immediately following TC meeting in Anaheim.
	Tools for Evaluating FDD	John House	RTAR to be submitted by 8/01/01

2	Methods for AHUs (Was "Method of Testing FDD Tools for AHUs") – WS-1312	Jonathan West Srinivas Katipamula Phil Haves	as TC 4.11 priority 2 RTAR for 2001. RTAR approved 9/01. Scope changed and RTAR re-submitted to RAC 8/02 and prioritized in Fall 2002. Draft WS exists. WS approved by email ballot in Fall 2003. RAC returned it by vote of 5-0-0 01/04: RAC comments addressed in Anaheim. Revised to address two TC 7.5 negative votes. John House obtained commitment to consider co-sponsorship by TCs 1.4, 7.3 and 7.4. TC 9.1 committed to providing a letter of support. TC 7.5 voted approval to submit revised version to RAC. PES formed.
3	Design and Demonstration of a Self-Configuration Concept for an HVAC Control System	Michael Kintner-Meyer	RTAR submitted to RAC 8/02 and prioritized in Fall 2002. Draft WS exists. 01/04: WS to be revised by 03/04 and distributed for review by TC 1.4 and TC 7.5 volunteers and then revised further if necessary by the 06/04 meeting.
4	Fault Detection and Diagnostics for Centrifugal Chillers – Phase 3: Real-Time Implementation	Jim Braun John House Srinivas Katipamula	RTAR to be submitted to RAC by 8/01/03 as priority 1 RTAR for 2003. RAC comments suggest waiting on WS submittal until Phase 2 is completed.
5	Real-Time Optimal Control in a Distributed Environment	Jim Braun George Kelly Maria Corsi	RTAR to be submitted to RAC by 8/01/03 as priority 2 RTAR for 2003.. 1/04: WS has not been drafted yet. TC 7.5 will continue to monitor progress in TC 7.4 and co-sponsor.
6	Whole-Building FDD	Les Norford	New research idea proposed in Honolulu. 01/04: RTAR has not been drafted yet.
7	FDD for Supermarket Refrigeration	Daniel Choinière	New research idea proposed in Honolulu. 1/04: RTAR drafted and discussed in subcommittee meeting. Recommendations made to strengthen RTAR. Contact will be made with TC

			10.3, 10.7 and 10.9 to seek co-sponsorship.
8	Development of Tools for Assessing the Value of Demand Response Assets	Michael Kintner-Meyer	New research idea proposed in Honolulu.

Non-Prioritized Research Topics

- Prototyping and Field Testing of Utility-Consumer Information Services – Michael Kintner-Meyer and Marty Burns
- Resolving Discrepancies Between Multiple, Hierarchically-Related, Fault Detection and Diagnostic Systems – Michael Brambley
- Smart Sensor Systems for Reducing Bias Errors in the Measurement of Air Temperatures and Flows in Air-handling Units
    - 01/04: Art Dexter will prepare initial draft of RTAR. Charlie Culp will help.
- Wireless Research Topic
    - 01/04: Agami ready volunteered to help draft an RTAR in this general area. Michael Kintner-Meyer will assist.
- Integrating data in computer-based maintenance management systems with energy management and control systems.
    - 01/04: New topic suggested by Cliff Federspiel

Technical Papers from Sponsored Research

TC Sponsored Symposia (past 3 years, present, planned)

Title	**Date** (Given or Planned)
Recent Results from Fault Detection and Diagnostic Research (Norford)	Atlanta, 1/01
HVAC Diagnostics: Development to Implementation Part 1 (House)	Atlantic City, 1/02
HVAC Diagnostics: Development to Implementation Part 2 (Dexter)	Atlantic City, 1/02
FDD, Operation and Maintenance of HVAC Systems (Kelly, TC 1.4 cosponsor)	Kansas City, 6/03
Automated Commissioning Tools (Corsi)	Orlando

TC Sponsored Seminars (past 3 years, present, planned)

Title	Date (Given or Planned)
Diagnostics from an Operations Perspective, Needs and Experiences (Rossi)	Atlanta, 1/01
Adding New Life to Old System-Control Retrofit Case Studies (TC 1.4 lead)	Atlanta, 1/01
Maximizing Facility Performance with Computerization and Controls (Gartner)	Cincinnati, 6/01
Data Modeling for Building Operations (Kintner-Meyer)	Cincinnati, 6/01
BACnet Manufacturers Association (BMA)- New role in Testing Interoperability of BACnet Systems (Newman)	Cincinnati, 6/01
Wireless DDC Systems (TC 1.4, Bridges lead)	Cincinnati, 6/01
Intelligent Agents - What They Can Do For You (Ahmed, TC 4.6 co-sponsor)	Honolulu, 6/02
Self-Configuring Control Systems: Technology and Potential Benefits (Brambley, TC 4.6 co-sponsor)	Honolulu, 6/02
Experience with Demand Responsiveness Programs (Haves, TC 4.6 co-sponsor)	Honolulu, 6/02

New Issues in State of the Art DDC Systems (Atkinson, TC 1.4 co-sponsor)	Honolulu, 6/02
Automated Functional Testing of HVAC Systems (Haves, TC 1.4 and 4.6 co-sponsors)	Chicago, 1/03
New Issues with State-of-the-Art DDC (Atkinson, TC 1.4 and 1.5 co-sponsors)	Chicago, 1/03
Wireless Sensors for Building Applications (Healy, TC 1.4 co-sponsor)	Kansas City, 6/03
Improved Operations for California Buildings -Part II (Chris Scruton, co-sponsored with TC4.6)	Anaheim
Automated Commissioning Tools (Marie Corsi, co-sponsored with TC 9.9 and possibly TC 1.7)	Anaheim
FDD from an Operator's Perspective (Rossi)	Future

TC Sponsored Forums (past 3 years, present, planned)

Title	Date (Given or Planned)
Specifying Open Lonmark DDC Systems	Atlantic City, 1/02
What Should ASHRAE's Role be in IFC and XML Standards (Gowri, GPC20 and TC 1.5 cosponsor)	Chicago 1/03
Wireless Sensors for HVAC Systems(Brambley)	Kansas City
Addressing the Need for Data Modeling Beyond Building Design- What Role Should ASHRAE Play	Future
New Sensor Technology, Other New Technologies (Kintner-Meyer)	Future

TC Sponsored Public Sessions (past 3 years, present, planned): None
Journal Publications (past 3 years, present, planned): None

TC 7.5 Minutes
Anaheim, CA
Notes by: Todd Rossi

Call to Order, Roll Call, Introductions

The meeting was called to order by Chairman John House. Introductions were made and the agenda was distributed for review (Appendix A). House read the scope of the committee and a roll call was taken. Thirteen of fourteen voting members (including the chair) were present.

Motion to approve the agenda

Mike Brandemuehl motion; Jim Gartner second; motion approved by unanimous voice vote

Minutes from Previous Meeting

Minutes from the 2003 Annual Meeting in Kansas City were distributed. House noted that he had identified several minor revisions and would provide these to the Secretary, Todd Rossi.

Motion to accept minutes subject to minor revisions

Gartner motion; Brandemuehl second; motion approved by vote of 11-0-0 (Chair not voting). Carlos Haiad was out of the room at the time of the vote.

Chair's Announcements (John House):

1. Following the Nashville meeting, Technical, Energy and Government Activities (TEGA) and Chapter Programs are consolidating committees, to be called Chapter Technology Transfer (CTT). The goal of CTT will be to provide excellent communications between society functions and the general membership. Jim Gartner, who will be a member of CTT, recommended TC members get more involved in local chapter activities.

2. ASHRAE is soliciting suggestions and proposals from TCs concerning possible standards, guidelines and research that would support ASHRAE Homeland Security efforts. Please be thinking about what role TC 7.5 might have in this area.

3. TC chairs from the new Section 7 (Building Performance) met Sunday morning with Section Head Pat Graef. This meeting focused on handbook activities, but future meetings will address other topics in an effort to better coordinate work being done by TCs with related interests.

4. TC 7.5 has roster spots to fill and is looking for individuals who are willing to get involved with program and research activities. Anyone interested should contact John House.

Technology Development Subcommittee (Srinivas Katipamula)

Phil Haves, PMS Chair for 1275-RP "Evaluation and Assessment of Fault Detection and Diagnostic Methods for Centrifugal Chillers – Phase II", led a discussion of the research project. The contract started January 1, 2004. Agami Reddy of Drexel University is the PI. This is a follow-on to 1043-RP and involves developing criteria for comparing FDD methods and then carrying out the comparison on four methods.

Srinivas Katipamula reviewed other research ideas that are being pursued by the Technology Development Subcommittee:

- An RTAR entitled "Real-time Optimal Control in a Distributed Environment" was prioritized by RAC at their fall meeting. Jim Braun was lead author on the RTAR. Katipamula collected names of volunteers who agreed to assist Braun with the development of the work statement.

- Daniel Choinière is taking the lead on developing an RTAR for the research topic "FDD for Supermarket Refrigeration". Choinière will try to coordinate with TC's responsible for supermarket refrigeration. It is important to build a case for why this research is needed. Mike Brandemuehl and Todd Rossi agreed to assist with the RTAR.

- The research topic "Whole Building FDD" has been on the research plan for some time now. Les Norford is listed as the lead. Haves agreed to help Norford draft an RTAR for the next meeting.

- Arthur Dexter is the lead on the research topic "Smart Sensor Systems for Reducing Bias Errors in the Measurement of Air Temperatures and Flows in Air-handling Units". Dexter is still interested in the topic. Charlie Culp agreed to assist in developing an RTAR. Katipamula will forward Culp's contact information to Dexter.

Agami Reddy suggested a new research topic on wireless sensors. Reddy will review minutes from previous meetings where this has been discussed and suggest next steps.

Communications and Integration Subcommittee (Rich Hackner for Peng Xu)

Rich Hackner led a discussion of activities of the Communications and Integration Subcommittee (Peng Xu, Subcommittee Chair, was absent). A prioritized RTAR entitled "Design and Demonstration of a Self-Configuration Concept for an HVAC Control System" has been expanded into a work statement and discussed at the last few meetings. It needs further revision and it seems appropriate to seek collaboration and co-sponsorship from TC 1.4. Mike Brambley and Phil Haves agreed to help with the revision by interating on its content several times before the next meeting. Dave Underwood of TC 1.4 also offered to assist.

Hackner also noted that the subcommittee would like to set aside more time at the next meeting to brainstorm new research ideas. Cliff Federspiel suggested a new research topic involving the integration of computerized maintenance systems with building control systems.

- House encouraged additional new ideas and asked whether the follow-on work to 1011-RP (development of data models that can interface buildings with utilities) is needed and/or should be pursued? The proposed follow-on work would involve demonstrating the use of the data models in a simulated environment. Emphasis would be on showing that these kind of communications are scalable such that information can be broadcast to millions of customers. When the work was initially proposed many years ago, it was deemed premature by the BACnet Committee. Is this work still needed? Bob Old pointed out that GPC20 is using a lot of the data models developed in 1011-RP in their models described in XML. The consensus of the group was to review this topic at the next meeting and decide next steps.

Testing and Evaluation Subcommittee (Natascha Castro)

Natascha Castro distributed and led a discussion with Srinivas Katipamula of the work statement "Tools for Evaluating Fault Detection and Diagnostic Methods for Air-Handling Units". The work statement was submitted to RAC and considered at their Fall meeting. RAC rejected the work statement by a vote of 5-0-0, citing the need to coordinate and gain support from other TCs and to eliminate the two negative votes on the TC. Details of comments associated with the negative votes by the TC and comments from RAC are provided in under the section "Summary of TC 7.5 Research Activities since the Kansas City Meeting"

Katipamula summarized the objectives of the research and the main tasks to be completed by the contractor. Katipamula also identified changes to the work statement suggested at the subcommittee meeting Sunday. It was also pointed out that TC 1.4, 7.3, and 7.4 have agreed to co-sponsor the research and that TC 9.1 will likely provide a letter of support.

Motion to approve the work statement "Tools for Evaluating Fault Detection and Diagnostic Methods for Air-Handling Units" subject to minor revisions
Katipamula motion; Clarification – This is a motion to resubmit to RAC by May 15 for their consideration; Wright second 12-0-0 (Chair not voting)

Agami Reddy suggested House explain changes to work statement in cover letter to Mike Vaughn. House agreed.

House will request an slot in the PES to ensure all co-sponsoring committees are adequately represented and to ensure the PES and PMS have the appropriate experience with both simulation software and field evaluation of equipment performance. The PES will consist of Phil Haves (Chair), Dave Underwood (TC 1.4 representative), Jim Gartner (TC 7.3 representative), Srinivas Katipamula (TC 7.4 representative), and John House (TC 7.5). Phil Haves agreed to chair the PES and PMS.

Castro announced that the RTAR "Fault Detection and Diagnostics for Centrifugal Chillers – Phase 3: Real-Time Implementation" has been prioritized by RAC, however, RAC suggested that the TC delay submitting a work statement until the second phase of the research (1275-RP) is completed. Castro will bring up this topic again at Nashville.

Research Subcommittee (Mike Brambley)
Mike Brambley led a discussion of the overall research plan and status of research topics and projects. The plan will be updated based on discussions at this meeting and forwarded to the Secretary for inclusion in the minutes (see page ??).

Brambley attended Research Chairs Breakfast Meeting on Monday and summarized main points for the TC:

- ASHRAE has updated the distribution of funding by research category effective 11/24/03. Brambley reviewed the percentages.
- ASHRAE is looking for a TC to review an unsolicited proposal on the topic of snow louver penetration. The consensus of the TC was to decline review.
- ASHRAE is encouraging research topics that address safety under extraordinary incidents.
- TC's are encouraged to use email alias for research liaisons. The appropriate address for TC

7.5 is RL7@ASHRAE.ORG.

- RTARs should be developed into work statements within one year after approval. RAC may not consider work statements for RTARs that are more than two or three years old.
- The mail box for the Manager of Research and Technology Services has moved. Please be aware when dropping off the information on contractor selection for 1274-RP.
- Revised work statements submitted to ASHRAE Headquarters by May 15 will be considered by RAC at the summer meeting in Nashville.
- There continue to be complaints about the contractor selection process. This is due to incidents where the process has progressed to the point where contractors have been selected, only to have higher-level ASHRAE committees terminate the project. The process is under review. These incidents seem to occur when the membership of a committee changes. New members may not agree with the position taken by previous committee members. To avoid these types of problems, TCs are encouraged to develop work statements within a year of the RTAR approval. Brambley will keep the TC informed of developments.
- RTARs should be 2 pages in length and absolutely no longer than 3 pages.
- The format of RTARs and work statements has changed slightly. Brambley will forward electronic version of the new format to Webmaster when he receives it. Mike Brandemuehl noted that Mike Vaughn plans to have this available within a month.
- RTARs are a skeleton for the full work statement. Full work statements should include references to demonstrate authors are aware of related work and combat any criticism that the work has already been done.
- Work statement cover sheets should clearly indicate co-sponsoring TCs. In addition, explanations for negative votes, abstentions and absences must be provided.
- Be careful about real or perceived conflicts of interest with research projects. Work statement authors can bid on research projects, but their involvement with the development of the work statement must be clearly stated. This is a problem primarily when there are a small number of bidders.
- RTARs and the long-range research plan are due to ASHRAE by Aug. 1, 2004.
- ASHRAE copyright is being revised.

House asked the subcommittee chair to make sure individuals writing new RTARs and work statement receive the new format requirements.

A 100-word summary has been added to the Work Statements outline. This summary is to briefly summarize the current state-of-the-art, the advancement this project is expected to accomplish, and its value to ASHRAE and society in general.

Once a work statement has been accepted and/or prioritized by RAC, it should not be changed. Non-accepted/priorized work statements can be revised.

Program Subcommittee (Hackner)

Rich Hackner led the discussion of program. Three seminars were submitted for the Anaheim program and two were selected.

House noted that TC 7.5 sponsored Seminar 45, the second part of a two-part seminar on the topic of improved operations for california buildings, was scheduled at the same time as a seminar TC 7.5 co-sponsored with TC 1.4. This had a considerable impact on the attendance at

Seminar 45, which was roughly half that at the first seminar on the same topic. Brambley suggested the Chair write a letter to ASHRAE's Program Committee to point out this conflict so they are more sensitive to this issue in the future. House suggested that all titles of sponsored and co-sponsored programs be listed as potential conflicts when programs are submitted to ASHRAE. House also thanked Carlos Haiad for pulling together the two-part seminar.

Discussion of program ideas led to the following proposed program for Nashville:

Priority 1. Seminar: Models for Automated Building/HVAC Diagnostics (Chair: Michael Brambley)
Priority 2. Seminar: In 2010: What Will a Building Have to Say? ….and Who Will Listen? (Chair: Phil Haves)
Priority 3. Forum: What the Utility Wants to Do to Your Building and How You will Benefit (Chair: Michael Kintner-Meyer)

Motion to accept the prioritized program for Nashville
Srinivas Katipamula motion; Carlos Haiad second; motion approved by 12-0-0 (Chair not voting)

Haiad noted that TC 10.7 is looking for co-sponsorship of a forum entitled "What are the Needs for FDD in Commercial refrigeration facilities?" The consensus was that this was a topic of interest to TC 7.5 and House, speaking for the committee, stated that TC 7.5 would co-sponsor the forum.

Future program plans include a symposium (perhaps two) that Haves is planning that would report international research efforts in the area of commissioning that has been performed during IEA Annex 40. The symposium is tentatively planned for the winter meeting in Orlando.

In related program activities, Haves explained that he has asked the Pat Graef, TAC Section 7 Head, to have TAC sponsor a forum to explore whether there is a need for special publication on building operations. This would parallel some activities exploring whether there is a need for an ASHRAE design guide. Haves asked if TC 7.5 would be willing to co-sponsor the forum with TC 7.4 if TAC will sponsor. House expressed a willingness to do so.

Hackner announced that Nashville programs are due February 14.

House reminded everyone of the seminar on Wednesday morning on Automated Commissioning Tools. House also noted that we are getting a lot of Wednesday morning slots. Others seemed to agree. Brambley suggested that House review past programs and document the number of times this has occurred recently, and then write a letter to the Program Committee to voice the committee's frustration over this situation. House agreed to do this.

Old Business
Wayne Dunn announced that presentations from the XML symposium presented at the AHR Expo are available. Haves indicated that one or more of the symposium speakers might be good speakers for the seminar "In 2010: What Will a Building Have to Say? ….and Who Will Listen?" Glenn Remington offered to provide a list of symposium speakers and affiliations.

House asked Natascha Castro if she would continue as Webmaster and Castro agreed to do so.

Castro announced that ASHRAE has offered to host TC web sites, but that she prefers to keep it at NIST. Everyone supported Castro's position. Castro also announced that ASHRAE is going to be providing new services to encourage better communication, including a list serve to broadcast emails for the TC, and an online forum service.

Mike Brandemuehl asked about the status of a handbook chapter for TC 7.5. House indicated that there has been discussion about a handbook chapter, including whether it is appropriate to have a separate chapter for TC 7.5 or to include the material in another chapter. Brandemuehl indicated that he is Handbook Chair for TC 7.4 and that the Applications Volume of the Handbook, in which the 7.4 material is published, is due in 2.5 years, making this an ideal time to discuss the possibility of including the material with material from TC 7.4. House will ask Les Norford, Handbook Chair, to explore the issue further with Brandemuehl.

New business

Carlos Haiad raised the issue of the requirement that Seminar Chairs compile a summary sheet for the evaluation forms. He has 180 evaluation forms to process before leaving the meeting. Haiad suggested that ASHRAE automate this process. Brambley stated that he thinks this requirement is a burden on session chairs and suggested it would be appropriate to write a letter to the Program Committee to point out that while the TC agrees with the need for feedback from programs, the TC feels completing the summary form is asking too much of session chairs. House will include this issue in the letter he is planning to write to the Program Committee concerning program scheduling. Brambley also suggested it may be okay to fax or email the summary form to ASHRAE after the meeting.

Executive Session

TC voted to recommend a contractor for 1274-TRP "Field Performance Assessment of Package Equipment to Quantify the Benefits of Proper Service" by a vote of 12-0-0 (Chair not voting). One member was absent for the vote because he is out of the country.

Summary of TC 7.5 Research Activities since the Kansas City Meeting

1. An email ballot was conducted to approve the RTAR "Fault Detection and Diagnosis for Centrifugal Chillers - Phase 3: Real-Time Implementation." The motion and second follow:

   MOTION: Move to approve the RTAR entitled "Fault Detection and Diagnosis for Centrifugal Chillers - Phase 3: Real-Time Implementation" and to submit the RTAR to the ASHRAE Research Administration Committee as the top priority RTAR for 2004-2005 of TC 7.5. (Philip Haves; 2nd Jim Braun)

   The motion was approved by a vote of 10 FOR, 0 OPPOSED, 0 ABSTAIN, 3 not voting (no response to email), and chairman not voting. This RTAR and the RTAR "Real-Time Optimal Control in a Distributed Environment" were forwarded to ASHRAE on July 30, 2003.

2. An email ballot was conducted to recommend a contractor for 1275-TRP "EVALUATION AND ASSESSMENT OF FAULT DETECTION AND DIAGNOSTIC METHODS FOR CENTRIFUGAL CHILLERS – PHASE II." As a result of the email ballot, a contractor was recommended by a vote of 11 FOR, 0 OPPOSED, 0 ABSTAIN, chairman not voting.

The vote was forwarded to ASHRAE on August 17, 2003.

3. An email ballot was conducted to approve the work statement "Tools for Evaluating Fault Detection and Diagnostic Methods for Air-Handling Units." The motion and second follow:

   MOTION: I move to approve the work statement titled "Tools for Evaluating Fault Detection and Diagnostic Methods for Air-Handling Units." (Srinivas Katipamula; 2nd Agami Reddy)

   The motion was approved by a vote of 10 FOR, 2 OPPOSED, 0 ABSTAIN, 1 not voting (no response to email), and chairman not voting. The reasons for the negative votes are provided below:

   1. I think that Java (and maybe some other languages) should be allowable in Task 1.
   2. I can't understand the two-sentence description of Task 2.
   3. TC 7.5 should build more of a consensus for this validation methodology by petitioning other committees to support this research before asking ASHRAE to invest in this project.

The work statement was forwarded to ASHRAE on September 5, 2003 for consideration by the Research Administration Committee (RAC). The Research Activities Subcommittee (RAS) of RAC voted 5-0-0 to return the work statement. The following reasons were given for returning the work statement:

- Needs to be reviewed by our Research Liaison;
- Should strive to gain support from other TCs, such as those representing AHU manufacturers;
- Should strive to eliminate negative votes within the TC.

Since receiving the comments, minor revisions have been made to the work statement to address comments 1 and 2. In addition, the following TC's have been contacted concerning co-sponsorship of the work statement:

TC 1.4 Control Theory Application
TC 7.9 Commissioning
TC 7.5 Building Operation Dynamics
TC 9.1 Large Building Air-Conditioning Systems
TC 6.3 Forced Air Heating and Cooling Systems
TC 7.3 Operations and Maintenance Management
TC 7.7 Testing and Balancing
TC 1.2 Instruments and Measurement

Appendices

A. Call to Meeting and Agenda
B. Scope and Organization
C. Technology Development Subcommittee Report

D. Communications and Integration Subcommittee Report
E. Testing and Evaluation Subcommittee Report
F. TC4.11 Research Subcommittee meeting/Planning Session
G. Research Plan and Activities
H. List of Subcommittee and Committee Meeting Attendees

Appendix A.
Call to Meeting and Agenda

ASHRAE American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

1791 Tullie Circle, NE, Atlanta, Georgia 30329-2305 404-636-8400 | Fax 404-321-5478

Reply to: John House
Energy Resource Station

January 9, 2004

Dear TC 7.5 Member, International Member, or Corresponding Member:

The **TC** on Smart Building Systems will meet in the Anaheim Convention Center and its subcommittees will meet in the Anaheim Marriott, according to the following schedule:

TC 7.5	Tech. Development	Sunday (1/25)	3:00-3:45p	Marriott/Salon J (L)
TC 7.5	Comm. & Integration	Sunday (1/25)	3:45-4:30p	Marriott/Salon J (L)
TC 7.5	Testing & Evaluation	Sunday (1/25)	4:30-5:15p	Marriott/Salon J (L)
TC 7.5	Research	Sunday (1/25)	5:15-6:00p	Marriott/Salon J (L)
TC 7.5	**Smart Building Systems**	**Tuesday (1/27)**	**3:30-6:00p**	**Conv. Center/201 B**

TC 7.5 is sponsoring or co-sponsoring the following program sessions:

Seminar 40: Improved Operations for California Buildings: Part 1 (TC 7.4 sponsor; TC 7.5 co-sponsor)
Tuesday, January 27, 2004, 8:00 AM – 10:00 AM, Chair: Carlos Haiad

Seminar 45: Improved Operations for California Buildings: Part 2 (TC 7.5 sponsor; TC 7.4 co-sponsor)
Tuesday, January 27, 2004, 10:15 AM – 12:15 PM, Chair: Martha Brook

Seminar 48: State of the Art Issues for DDC Systems (TC 1.4 sponsor; TC 7.5 co-sponsor)
Tuesday, January 27, 2004, 10:15 AM – 12:15 PM, Chair: Gaylen Atkinson

Seminar 58: Automated Commissioning Tools (TC 7.5 sponsor; TC 7.3 co-sponsor)
Wednesday, January 28, 2004, 10:15 AM – 12:15 PM, Chair: Maria Corsi

Attached is a draft agenda for the full TC 7.5 committee meeting. I hope to see you all in Anaheim.

John House
Chairman, TC 7.5

ASHRAE TC 7.5, Smart Building Systems
2004 Winter Meeting
Anaheim, CA

DRAFT AGENDA

Location: **Convention Center / 201B**
Date: **Tuesday, January 27, 2004**
Time: **3:30 - 6:00 p.m.**

1. Roll call and introductions

2. Approval of minutes from Kansas City

3. Announcements

4. Technology Development Subcommittee (Srinivas Katipamula)

   - Report on 1275-RP "Evaluation and Assessment of Fault Detection and Diagnostic Methods for Centrifugal Chillers – Phase II" (Phil Haves – PMSC Chair)
   - Work statement for "Real Time Optimal Control in a Distributed Environment" (prioritized RTAR!)

5. Communications and Integration Subcommittee (Peng Xu)
   - Work statement for "Design and Demonstration of a Self-Configuration Concept for an HVAC Control System" (prioritized RTAR!)

6. Testing and Evaluation Subcommittee (Natascha Castro)
   - Work statement for "Tools for Evaluating Fault Detection and Diagnostic Methods for Air-Handling Units" (prioritized RTAR!)

7. Research (Mike Brambley)

8. Program Subcommittee (Rich Hackner)
   - Plans for Nashville (June 26-30, 2004) and Orlando (February 5-9, 2005)

9. Old business

10. New business

11. Adjournment

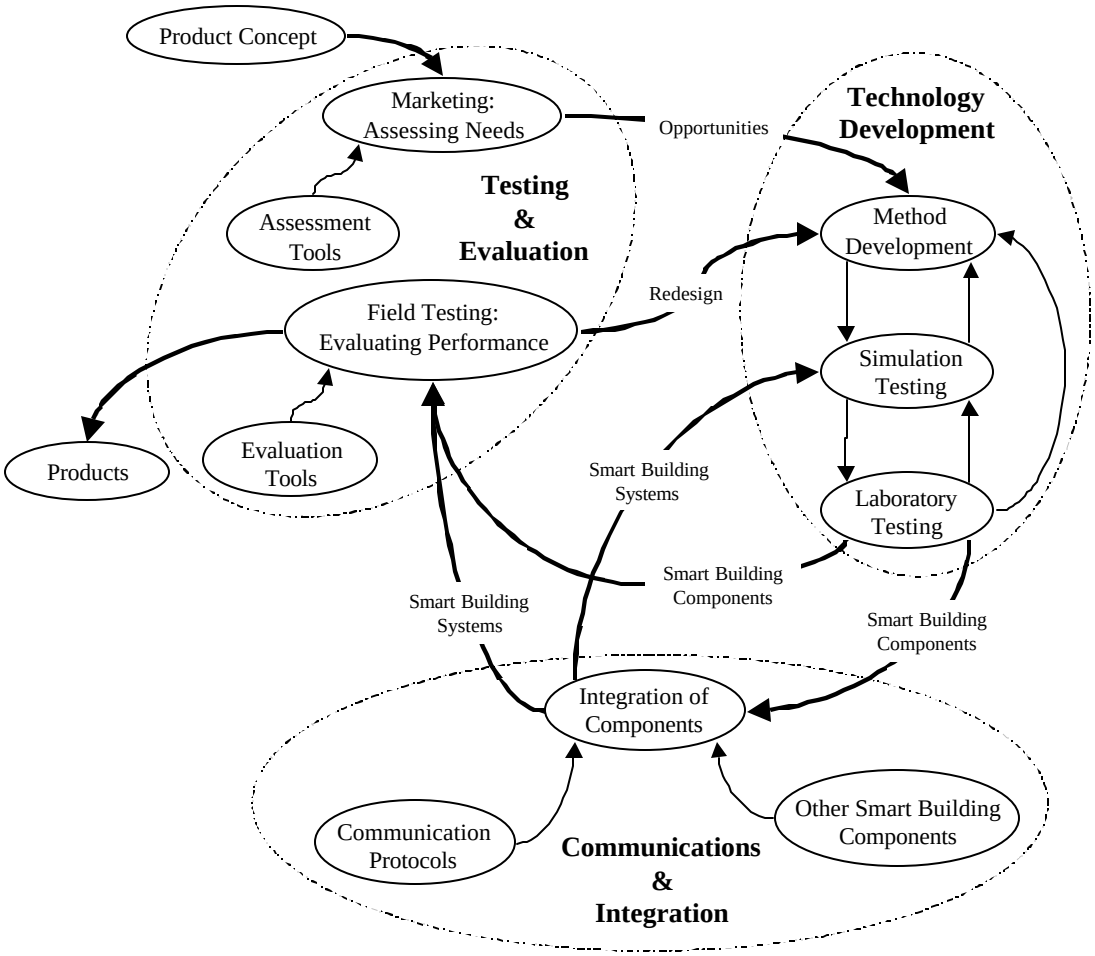
12. Executive session for voting members
    - Selection of contractor for 1274-TRP, "Field Performance Assessment of Package Equipment to Quantify the Benefits of Proper Service"

Appendix B.
TC 7.5, Smart Building Systems Scope and Organization
Revised July 1, 2001

Overall Committee Scope

The Technical Committee on Smart Building Systems (SBS), TC 4.11, is concerned with the development and evaluation of technologies that could enable the widespread application of smart building systems. "Smart" buildings should take advantage of automation, communications, and data analysis technologies in order to operate in the most cost-effective manner. This implies integration of building services such as HVAC, fire, security, and transportation; the automation of many of the operation and maintenance functions traditionally performed by humans; and the interaction with outside service providers such as utilities, energy providers, and aggregators. Currently, three subcommittees form the backbone of the TC's activities: technology development, communications and integration, and testing and evaluation. The scope and activities of these subcommittees loosely follow the product development process as depicted in following flow chart and as defined in the following sections.

Smart Building System Development Process



Appendix C.
TC7.5 Technology Development Subcommittee Meeting
Notes by: Srinivas Katipamula

Tech Development Subcommittee Minutes

Srinivas Katipamula began the meeting, announcing that the main focus of the meeting was to talk about the work statement and new ideas. He distributed the signup sheet along with the list of Technology Development Subcommittee Research Summary.

Active Research Projects

Srinivas reported that the contractor for FDD for Centrifugal Chillers- Phase 2 was awarded to Drexel University in October. No progress is reported to date but the PMS will be meeting just prior to the general meeting of TC 7.5.

Active Research Topics

1) Real Time Optimal Control in a Distributed Environment is being championed by TC 7.4, which TC7.5 will be co-sponsoring, not progress on the work statement was reported.

2) Smart Sensor Systems for Reducing Measurement Errors in AC Systems- Arthur Dexter reported that he is interested in the topic and questioned whether the topic would be of interest to practitioners. Srinivas reported Culp did work on sensor bias using ANN and was interested in working with 7.4 on RTAR.

New Ideas

1) Daniel Choniere distributed a draft RTAR for development of FDD for Supermarket systems. General comments from members included work with Industry and controls providers, at present the operators of the systems are not looking at operation side, and there is a demonstration in Canada. RTAR addresses refrigeration and AHU equip at equipment level and secondly at operation level (coordination).

Haves: Expectation from RAC and above is to show more of the need, need to present info on need for improved reliability and diagnosis for specific types of faults. Research forum stressed specific justification for individual projects. Solicit info from industry expertise to show need. Srinivas suggested that we contact other TCs 10.3, 10.7, and 10.9 for possible co-sponsorship.

Rossi added for Chiller systems we began with simulation and models laboratory testing, this RTAR jumps those steps. Choniere stated IEA is considering developing modeling work to evaluate. Here we begin with identifying potential fault.

Srinivas added could model this more closely to Chiller phase 1. Srinivas recommended getting 10.7's feedback and look to Chiller Phase 1

Other volunteers for RTAR (Rossi, Braun suggested talking to Mike Brandemuhl)

2) Resolving Discrepancies (moved to

3) Reddy volunteered to work on wireless RTAR.

4) On-line optimum covered under Real Time

5) Whole building FDD (les) idea from Honolulu - volunteers (Haves).

Other topics: None

Program:
Rich Hackner has nothing from last time

Previous MKM ideas:

1) Summer Nashville seminar: Wireless sensors for building controls: present and future technology.

Get a manufacturers, researcher and building operator (wireless 101, hands on- how do you do it) to speak.
Healy had a similar seminar at Kansas City. Need to expand on distinction between two and look at seminar in Anaheim.

2) Orlando seminar: Wireless sensor for building controls
3) (experience from current users)

Forum idea: related to supermarkets RTAR (Leverage with 10.7 and 10.3). Carlos will look into co-sponsorship.

New program ideas: Symposium related to IEA Annex - Papers needed by April 2nd. Haves though it may be premature - new target for Denver. Papers would be due Sept 24th, 2004 "International developments in Building Commissioning: commissioning process, and automated tools" Could have 2 linked symposium - one for 7.9 on process and the other on technology. Corsi can go to 7.9 for program meeting in Nashville to seek co-sponsorship of double symposium. (Haves)

Appendix D.

TC 7.5 Communications/Integration Subcommittee
January 25, 2004 (Anaheim Meeting)
Notes by: Rich Hackner for Peng Xu and Todd Rossi

- Workstatement: Design and Testing of a Self-configuration Concept for HVAC Control System
    a. Re-draft distributed
    b. Currently has a priority ranking by RAC
    c. Coordinate with 1.4 Peng to follow-up
    d. Next steps
        i. Tighten workscope
        ii. Michael Brambley, Bob Old and Phil Haves to assist in re-write
        iii. Next revision by end of February
- Reviewed Subcommittee Objectives
    a. Information
    b. Integration
- Discussed new ideas
    a. Integration of Computer-based Maintenance Systems with Digital Control Systems- Cliff Federspiel offered the idea and will bring more details to next meeting
- Talked about devoting a portion of the next meeting to new idea discussion

Appendix E.
TC4.11 Testing and Evaluation Subcommittee Meeting
Sunday, January 25, 2004
Natascha Castro: Chair

John House updated on the status of the work statement "Tools for Evaluating FDD Methods for AHUs".

Two negative votes:
No co-sponsors, seek out co-sponsors with other relevant TCs

John indicated that a number of tools have been developed on AHU FDD tools over the past decade, but we still use different metrics to judge the capabilities of the tools uniformly.

John made changes to the work statement (highlighted sections in the new WS), which he described (check the marked sections of the workstation).

IEC is donating time to use the facility to collect data to validate the model. John approached TC 1.4 co-sponsor, no answer yet. Maria approached TC 7.9 for co-sponsorship, TC 7.9 is interested but will not take any action at this meeting. John will meet with 9.1 Tuesday afternoon (Mark Fly? is the contact).

Agami asked what fraction of the work is new. John indicated that there is a lot of work done; would be integration of all the previous work to develop a tool that can be used for evaluating AHU FDD tools

Agami questioned the need for dynamic models. The idea the dynamic model is to capture the time response, although the application may end up being steady-state. John also indicated that dynamic piece is not important.

Phil said you need dynamic models to generate data to test steady state filters that are generally used in the FDD tools. There aren't good models that can generate "faulty" data, so we need a good model that can not only generate "normal" data but also "faulty" data.

Chris Scruton asked, do we need to perform a field survey to get the list of prevalent faults?

Phil suggest that couple of sentences be added to indicating simulation will not do the whole job, but it will improve the state-of-art significantly.

J. Wright had a problem with the word "standard format". **Phil suggested that we change the word "standard" to "useful" on page 3 second bullet of the WS.** Arthur asked will the IEC data (from previous ASHRAE work) be used? John Wright responded that although the faults are artificial, they can be used to validate the simulation tool. J. Wright said the simulation tool should be more flexible.

John House suggested that the contractors should understand the usefulness of the data sets and to propose how they would use it.

Brambley asked John House what additional changes need to made, because we are very close to getting this approved by RAC.

J. Wright said we need to get data from real building to understand the coil fouling issue.

Add to the background, still a simulation without alleviating the need for lab and field testing. Another change on pg. 4 … Arthur's suggestion …

Peng suggested that we have some limitation on sensor output. J House suggested that it is FDD tool that should adapt to the available data and didn't want to limit the sensor output.

Phil suggested that this is not a WS to develop methodology for FDD.

Phil asked why we had "Tools" in the title … J House mentioned that deliverable are: data sets, simulation tool (therefore the word tools).

Chris asked whether we need to add multiple fault capabilities to the WS, J House will add it to the WS.

Wayne Reedy commented that he will be an advocate for the WS … he also commented on the outcome of the Forum on long range research.

Natascha stated that the next meeting will be focused on discussions of the RTAR on Chiller Phase 3.

Appendix F.
TC7.5 Research Subcommittee Meeting
January 25, 2004 - Anaheim
Subcommittee Chair: Mike Brambley
Meeting Notes taken by Srinivas Katipamula

Brambley called the meeting to order and noted that reviews of RTARs, Work statements, and new ideas had been covered in each of the previous subcommittee meetings and would only be reviewed briefly in the Research Subcommittee meeting.

Daniel Chenoire suggested that the committee change the title of the RTAR on supermarkets to better reflect the content of the RTAR. He explained that in supermarkets there is a big difference between refrigeration systems and HVAC systems. FDD for the refrigerant side is similar to other vapor compressor FDD but there are differences beyond that, so we should change the title from refrigeration FDD to HVAC&R FDD.

Chris Scruton indicated that refrigeration FDD is important because supermarket refrigeration uses a lot of energy. After some discussion of details, Brambley suggested that Chris and Daniel continue the discussion off line.

Brambley asked that the Chairs of the other TC 7.5 subcommittees provide him a sentence on the status on each of the items on the TC 7.5 Long Range Research Plan (LRRP) for which their subcommittee was responsible before 6 PM on Monday evening so he could include the information in a report at the full committee meeting on Tuesday afternoon.

Cliff Federspiel suggests that TC 7.5 consider a new topic – integration of CMS systems with FDD and EMCS. He observed that there is not much activity going on in this area, but it deserves consideration and suggested the committee take a look at this topic.

Brambley asked if attendees had any new ideas for TC 7.5 research and turned the meeting over to Peng Xu to continue discussion of new research topics begun in the Communications and Integration Subcommittee meeting.

Carlos Haiad observed that the committee had moved away from the building-utility interface area and explained that the topic was one of the attraction for him and other utility staff to participate in this ASHRAE committee and suggested that the committee again investigate this topic. He enumerated a number of questions, including: if you have a full blown EMCS can the utility talk to it. If you don't have an EMCS, can the utility talk to the thermostat? What are the technical barriers? Carlos thinks it is cost.

Steve Blanc noted that the BACnet Committee is looking at a series of extensions that would deal with utility interactions. Currently, lights in some schools in the PG&E area are being controlled by the utility, but this is still controversial. The technology exists, but it is costly.

Steve suggested that it would be nice to have automated load curtailment.

Peng Xu suggested a research topic on standard EMCS naming convention.

Attendees agreed to continue discussion of this topic at the next meeting.

Appendix G.
TC 7.5 Smart Building Systems
Research Plan and Activities

July 2003
(status updated January 2004)

Research Objectives: The long-term goal of TC 7.5 is to conduct research on topics that will lead to the development and application of "smart" building systems. "Smart" buildings of the future will take advantage of automation, communications, and data analysis technologies in order to operate in the most cost-effective manner. A smart building would most likely have fully integrated control of building services such as HVAC, fire, security, and transportation. Integrated systems would reduce initial costs and could be "supervised" so as to meet the primary objectives of comfort, safety, and performance at minimum operating cost. In addition, the integration of the hardware and software for operation and monitoring of equipment would lead to reductions in support staff needs and improved equipment reliability. Further cost reductions and reliability improvements would be possible through the integration of automated techniques for detection and diagnosis of equipment faults. Ultimately, "smart" building systems could facilitate the use of "remote" support staff that operates, monitors, and maintains a number of different buildings from a centralized location. At this higher level, a smart building might communicate and inter-operate with other smart buildings for the purpose of load aggregation and centralized control and with outside service providers, such as utilities, energy providers, aggregators, and newly developing companies providing fault detection, automated commissioning, optimization, and other innovative services. In addition to the savings in operating costs associated with "smart" buildings, other benefits include energy conservation and enhanced occupant safety and comfort.

Three subcommittees form the backbone of the TC's activities: Technology Development, Communications and Integration, and Testing and Evaluation. The Technology Development Subcommittee is concerned with research issues associated with the development of emerging smart building technologies such as automated commissioning, performance monitoring, fault detection and diagnosis, optimal maintenance scheduling, and optimal control. The primary outcome of research endorsed by this subcommittee is expected to be data and models that enable development of the technologies and comprehensive methods that are the basis of the technologies. The Communications and Integration Subcommittee is concerned with research issues associated with enabling the seamless interaction of smart building components and services. An important aspect of this work is to identify the information that is necessary to support smart building technologies, and to identify the requirements of communication protocols to support the exchange of this information between different building services, between buildings and utilities, between multiple buildings, with outside service providers, etc. The Testing and Evaluation Subcommittee is concerned with research issues associated with assessing the benefits (market potential) and performance of smart building technologies. Research endorsed by this subcommittee is expected to result in data, metrics, methods, and tools/standards/guidelines for quantifying smart building system benefits and performance in a standardized manner, as well as findings from the actual application of these metrics, methods and tools.

Current TC 4.11 research includes projects in many of these areas. The evaluation of communication protocol requirements between utilities and energy management systems was

addressed in the recently completed research project 1011-RP. Fault detection and diagnostics (FDD) is being considered for a number of different HVAC applications. Demonstration of the performance and benefits of current FDD approaches for air handling systems was performed as part of the recently completed research project 1020-RP. Tools for enabling the assessment of FDD methods for chillers are being developed in 1043-RP, while the development of on-line training techniques for model-based FDD methods is being carried out in 1139-RP for vapor compression equipment.

Non-Prioritized Research Topics

- Prototyping and Field Testing of Utility-Consumer Information Services – Michael Kintner-Meyer and Marty Burns
- Resolving Discrepancies Between Multiple, Hierarchically-Related, Fault Detection and Diagnostic Systems – Michael Brambley
- Smart Sensor Systems for Reducing Bias Errors in the Measurement of Air Temperatures and Flows in Air-handling Units
    - 01/04: Art Dexter will prepare initial draft of RTAR. Charlie Culp will help.
- Wireless Research Topic
    - 01/04: Agami ready volunteered to help draft an RTAR in this general area. Michael Kintner-Meyer will assist.
- Integrating data in computer-based maintenance management systems with energy management and control systems.
    - 01/04: New topic suggested by Cliff Federspiel

Technical Papers from Sponsored Research

TC Sponsored Symposia (past 3 years, present, planned)

Title	**Date** (Given or Planned)
Recent Results from Fault Detection and Diagnostic Research (Norford)	Atlanta, 1/01
HVAC Diagnostics: Development to Implementation Part 1 (House)	Atlantic City, 1/02
HVAC Diagnostics: Development to Implementation Part 2 (Dexter)	Atlantic City, 1/02
FDD, Operation and Maintenance of HVAC Systems (Kelly, TC 1.4 cosponsor)	Kansas City, 6/03
Automated Commissioning Tools (Corsi)	Orlando

TC Sponsored Seminars (past 3 years, present, planned)

Title	Date (Given or Planned)
Diagnostics from an Operations Perspective, Needs and Experiences (Rossi)	Atlanta, 1/01
Adding New Life to Old System-Control Retrofit Case Studies (TC 1.4 lead)	Atlanta, 1/01
Maximizing Facility Performance with Computerization and Controls (Gartner)	Cincinnati, 6/01
Data Modeling for Building Operations (Kintner-Meyer)	Cincinnati, 6/01
BACnet Manufacturers Association (BMA)- New role in Testing Interoperability of BACnet Systems (Newman)	Cincinnati, 6/01
Wireless DDC Systems (TC 1.4, Bridges lead)	Cincinnati, 6/01
Intelligent Agents - What They Can Do For You (Ahmed, TC 4.6 co-sponsor)	Honolulu, 6/02
Self-Configuring Control Systems: Technology and Potential Benefits (Brambley, TC 4.6 co-sponsor)	Honolulu, 6/02
Experience with Demand Responsiveness Programs (Haves, TC 4.6 co-sponsor)	Honolulu, 6/02
New Issues in State of the Art DDC Systems (Atkinson, TC 1.4 co-sponsor)	Honolulu, 6/02
Automated Functional Testing of HVAC Systems (Haves, TC 1.4 and 4.6 co-sponsors)	Chicago, 1/03
New Issues with State-of-the-Art DDC (Atkinson, TC 1.4 and 1.5 co-sponsors)	Chicago, 1/03
Wireless Sensors for Building Applications (Healy, TC 1.4 co-sponsor)	Kansas City, 6/03
Improved Operations for California Buildings -Part II (Chris Scruton, co-	Anaheim

sponsored with TC4.6)	
Automated Commissioning Tools (Marie Corsi, co-sponsored with TC 9.9 and possibly TC 1.7)	Anaheim
FDD from an Operator's Perspective (Rossi)	Future

TC Sponsored Forums (past 3 years, present, planned)

Title	Date (Given or Planned)
Specifying Open Lonmark DDC Systems	Atlantic City, 1/02
What Should ASHRAE's Role be in IFC and XML Standards (Gowri, GPC20 and TC 1.5 cosponsor)	Chicago 1/03
Wireless Sensors for HVAC Systems(Brambley)	Kansas City
Addressing the Need for Data Modeling Beyond Building Design- What Role Should ASHRAE Play	Future
New Sensor Technology, Other New Technologies (Kintner-Meyer)	Future

TC Sponsored Public Sessions (past 3 years, present, planned): None
Journal Publications (past 3 years, present, planned): None

Appendix H.
List of Subcommittee and Committee Attendees

Anaheim, CA – January 2004

	Main Committee	Technology Development	Communications & Integration	Testing & Evaluation	Research
Voting Members					
Osman Ahmed (V)					
Mike Brambley, Testing and Evaluation Subc, CM (V)	X	X	X	X	X
Michael Brandemuehl (V)	X	X	X	X	X
James Braun (V)	X		X		X
Natascha Castro, Secretary, Web Master (V)	X	X	X	X	X
Arthur Dexter, International member (V)	X	X	X	X	X
Cliff Federspiel (V)	X	X	X	X	X
Rich Hackner, Program Subc. (V)	X	X	X	X	X
Carlos Haiad, (V)	X	X	X	X	X
Phil Haves, (V)	X	X	X	X	X
John House, Chair	X	X	X	X	X
Srinivas Katipamula, Tech. Dev. Subc. Chair (V)	X	X	X	X	X
Agami Reddy (V)	X	X	X	X	X
Non-Voting Members					
Eric Adams					
Narendra Amarnani					X
Peter Armstrong					
Don Aumann					
Kim Barker			X	X	
Steve Blanc, CM	X	X	X	X	X
David Bornside	X	X	X	X	X
Dave Branson, CM		X	X	X	X
Mark Breuker					
Barry Bridges, CM	X				
Marty Burns,CM					
Jim Butler, CM					
Par Carling					
Daniel Choiniere	X	X	X	X	X
Christian Christiansen					
Maria Corsi, CM	X	X	X	X	X
Charles Culp, CM					
Piotr Domanski					X
Jon Douglas					
Andy Drysdale					
Chris Early					
	Main	Technology	Communications	Testing &	Research

	Committee	Development	& Integration	Evaluation	
Thomas Engbring, CM					
Paul Francisco					
Theo Frutiger					
James W. Gartner, CM	X				
Brent Griffith					
Peter Gruber					
David Hansen					
Bill Healy	X	X	X	X	X
Kirstin Heinemeier					
Gregor Henze	X				
David Holmberg					
David Kahn, CM					
George Kelly, CM	X	X	X	X	X
Richard Kelso	X				
Michael Kintner-Meyer, Comm. and Integration Subc					
Hofu Kiu					
Curtis Klaassen					
Erin Kruse					
Damian Ljungquist					
Carol Lomonaco, CM, Program Subc					
Haorong Li					
Mingsheng Liu					
Tor Malmstron					
Rodney Martin					
Darrell Massie					
Robert McDowall					
John Mitchell , CM					
Ron Nelson, CM					
Les Norford					
Zach Obert					
Robert Old, CM	X	X	X		
Hung Mahn Pham, CM					
Kinga Porst, CM					
Michael Pouchak					
Andrew Price					
Barry Reardon, CM					
Wayne Reedy					X
Paul Reimer					
Glenn Remington, CM					
Todd Rossi, Fault Detection Diagnostics Subc, CM	X	X	X	X	X
Tim Salsbury					
Jeffrey Schein					
Chris Scruton	X	X	X	X	X
John Seem, CM					X

	Main Committee	Technology Development	Communications &	Testing & Evaluation	Research

			Integration		
Virgil Seribo					
David Shipley					
Vernon Smith					
Pornsak Songkakul, CM	X		X	X	
Gene Strehlow					
Keith Temple					
Matthew Tyler, CM			X		X
Hossein Vaezi-Nejad		X	X		X
Dave Underwood					
Jean Christopher Visier					
Jim Wen	X	X	X	X	X
Jonathan West					
James Winston, CM					
Jonathan Wright	X	X	X	X	X
Peng Xu,Comm. & Int. Subc. Chair, CM	X	X	X	X	X
Chariti Young, CM	X				
Jensen Zhang					
Song Zhang					
Xiaohui Zhou	X				